

## EGG ARCHITECTURE OF NAUCORIDAE (HETEROPTERA): INTERNAL AND EXTERNAL STRUCTURE OF THE CHORION AND MICROPYLE

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*Abstract.*—The chorion and micropyles of 27 species of Naucoridae, including 21 species of *Ambrysus*, are described and each description is supported with scanning electron micrographs. Photomicrographs of thick sections through the chorion or micropyle of 10 of these species also are presented. Chorionic sculpturing differs interspecifically in *Ambrysus* and based on the species studied, eggs of *Ambrysus*, *Limnocoris*, and *Pelocoris* have 2–3 micropyles.

*Key Words:* Egg, chorion, micropyle, Naucoridae

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The Naucoridae (*sensu lato*), or creeping water bugs, comprise 394 described species worldwide (see La Rivers 1971, 1974, 1976; Polhemus and Polhemus 1982, 1988, 1994; Nieser et al. 1993; Liu and Zheng 1994; Polhemus 1994; Nieser and Chen 1996). As is typical among insect families, the adults have received the greatest amount of morphological research; accordingly, taxonomic treatments emphasize adult characters. Although nymphal stages have been described for several species of Naucoridae, details of egg structure largely have been ignored. Line diagrams from light microscopy have been presented for a few species; however, elucidation of fine detail is not possible with this technique. Recent reports for several species [*Ambrysus lunatus* Usinger (Sites and Nichols 1990), *Cryphocricos hungerfordi* Usinger (Sites and Nichols 1993), *Pelocoris poeyi* Guérin Méneville (Sites 1991), and several species of South American *Ambrysus* and *Pelocoris* (López Ruf 1989)] have included scanning electron micrographs that have revealed interspecific differences in chorionic patterns.

Eggs of most naucorid species, for which oviposition is known, either are adhered to plants (exophytic oviposition) or to rock substrata (Hinton 1981). For example, eggs of *A. lunatus* are adhered to plants (Sites and Nichols 1990), *Ambrysus mormon* Montandon to pebbles (Usinger 1946), *Aphelocheirus aestivalis* (Fabricius) probably to rocks (Larsén 1927), *C. hungerfordi* to rocks (Sites and Nichols 1993), *Laccocoris limigenus* Stål to hard substrata (Clarke and Baroudy 1990), *Naucoris maculatus* F. to plants (Lebrun 1960), and *Pelocoris femoratus* (Palisot de Beauvois) to plants (Torre Bueno 1903, Hungerford 1927, McPherson et al. 1987). More specifically, *P. femoratus* eggs are glued to leaflets of *Nitella* and other aquatic plants with a "fairly generous quantity of white adhesive" (Hungerford 1927). In contrast, the oviposition of *Ilyocoris cimicoides* (L.) is endophytic, inserting eggs into submergent plant tissue (Cobben 1968), such as into stems of *Ranunculus* or water peppermint (Rawat 1939).

Eclosion occurs through the anterior pole and, generally, a crescentic slit is made

through the chorion. In *Coleopterochoris kleerekoperi* Hungerford and species of *Cryphocricos*, a predetermined fracture line exists, and in *I. cimicoides*, a well-defined operculum faces the water, whereas the remainder of the egg is embedded within the plant (see Rawat 1939).

Internally, the chorion of *Ilyocoris* and *Cryphocricos* is bilayered (Cobben 1968 and Sites and Nichols 1993, respectively), with a thick chorionic outer layer, which is perforated by pore canals, and a thinner, unperforated chorionic inner layer. Externally, scanning electron micrographs of six species of *Pelocoris* and two species of *Ambrysus* from Argentina revealed that the chorionic surface differed among species (López Ruf 1989). For the two species of *Ambrysus*, interspecific internal differentiation was subtle; however, marked differences existed externally. Therefore, López Ruf (1989) suggested that the external chorionic pattern is valuable as a taxonomic character and that internal chorionic attributes may be useful at the generic level.

Presented herein are scanning electron micrographs of the chorion and micropyles of 21 species of *Ambrysus* (subfamily Cryphocricinae) and selected species representing six additional genera and five additional subfamilies. Photomicrographs of thick sections of the micropyle and chorion for some species also are presented. Egg morphology is described for each species.

#### MATERIALS AND METHODS

Eggs were obtained by both oviposition and dissection. Oviposited eggs were preferred for examination because they were fully developed structurally. Thus, we brought live female naucorids into the laboratory and maintained them individually in glass petri dishes with enough water to submerge them. To provide a potential oviposition substrate, an aquatic plant stem (usually *Justicia americana*) was placed in each petri dish and live food provided for each naucorid generally as one corixid (*Corisella*, *Ramphocorixa*, *Sigara*) per naucorid,

daily. Most naucorids, including members of those species inhabiting lotic environments, oviposited on plants or on the dish. For the several species that did not oviposit in the laboratory or for which we did not have live specimens, eggs were dissected from females preserved in alcohol. Eggs were taken from only the common oviduct or vagina (sometimes erroneously referred to as ovarian eggs), rather than from the ovarioles, and were considered to be structurally well-developed because they were near the end of the reproductive tract. To allow a rapid evaluation of the reproductive tract to determine position of eggs and to minimize external damage to the specimen, a dissection technique was developed. With the insect in alcohol and ventral side up, the tip of a pair of jeweler's forceps was inserted into the membrane of the lateral margin of the 7th abdominal segment. By moving the forceps anteriorly, the sternum and laterotergites were separated from the terga of segments 4–7. The venter then was pulled laterally, separating along segmental sutures, thereby exposing the abdominal cavity. Eggs were gently removed from the abdomen with forceps and kept in 3.7 ml snap-cap glass vials in 80% ethyl alcohol.

Dissected eggs often had tissue from the reproductive tract adhered to them. To remove this tissue, an ultrasonic cleaner was used, which had a peak output of 40 watts and a frequency of 60 Hz. Vials containing eggs in ethyl alcohol were placed in the cleaner with a small amount of water for ca. 10 minutes: the exact amount of time depended on the amount of tissue to be removed. Various solublizers [e.g., Triton X-100, sodium dodecyl sulfate (SDS)] were ineffective in removing tissue. Subsequently, the eggs were examined under a microscope and any remaining tissue was carefully removed. Eggs then were transferred to fresh 80% ethyl alcohol.

To prepare eggs for critical point drying, both dissected and oviposited eggs in 80% ethyl alcohol were fixed with 2% glutaraldehyde in 0.1 M phosphate buffer, washed



Fig. 1. *Ambrysus circumcinctus*, cross section through micropylar plug distad of base.

in 0.1 M phosphate buffer, and dehydrated through a graded alcohol series to 100% ethyl alcohol, and then placed into 100% acetone. Eggs were then critical point dried and sputter-coated. For light microscopy, the above procedure was followed through the glutaraldehyde primary fixation. After washing in 0.1 M phosphate buffer, eggs were subjected to a secondary fixation in 2% osmium tetroxide in 0.1 M phosphate buffer. Subsequent dehydration techniques were as for the scanning microscopy preparation. Eggs were embedded in Spurr's resin, sectioned with a diamond knife, slide-mounted, and stained with toluidine blue. Voucher specimens of adults and eggs are housed in the Enns Entomology Museum, University of Missouri-Columbia.

#### DESCRIPTIONS OF EGGS

Little detail of the micropylar plug of most genera is evident externally that would allow the determination of the number of micropyles contained therein. Cross sections taken at levels above the base of the plug reveal numerous canals, including transverse canals, which represent convolutions of the same canal(s) throughout the plug (Fig. 1). However, the number of micropyles can be observed by sectioning through the base of the plug where it enters the egg. Thus, photomicrographs of thick

sections taken through the base of the plug are presented for some species.

Citations for the original description and subsequent descriptions of adults or immature stages are given for each species. Also given are collecting localities of females from which eggs were obtained, egg measurements ( $\text{mm} \pm \text{SE}$ ), sample size, and method of obtainment (i.e., oviposited or dissected). For all naucorid species examined, egg color was creamy white to beige.

#### Subfamily Cryphocricinae Montandon 1897a

##### Genus *Ambrysus* Stål 1862

##### *Ambrysus (Acyttarus) funebris* La Rivers (Figs. 2-5)

*Ambrysus funebris* La Rivers 1948a: 103-107.

USA: California, Death Valley National Monument

Length, 1.04; width, 0.38;  $n = 1$ ; dissected.

Overall appearance elongate with rounded, asymmetrical ends. Reticulation pattern consisting generally of pentagonal to heptagonal units, delimited by distinctly raised lines (Fig. 2). Within each unit, poorly defined, low, irregular protruberances. Aeropyles small, distinct, numerous, more than 50 per unit (Fig. 3). Anterior pole with reticulation and aeropyles lacking, with amorphous micropylar plug set in shallow concavity (Fig. 4).

Exochorion thicker than endochorion. Pore canals widest at base (Fig. 5).

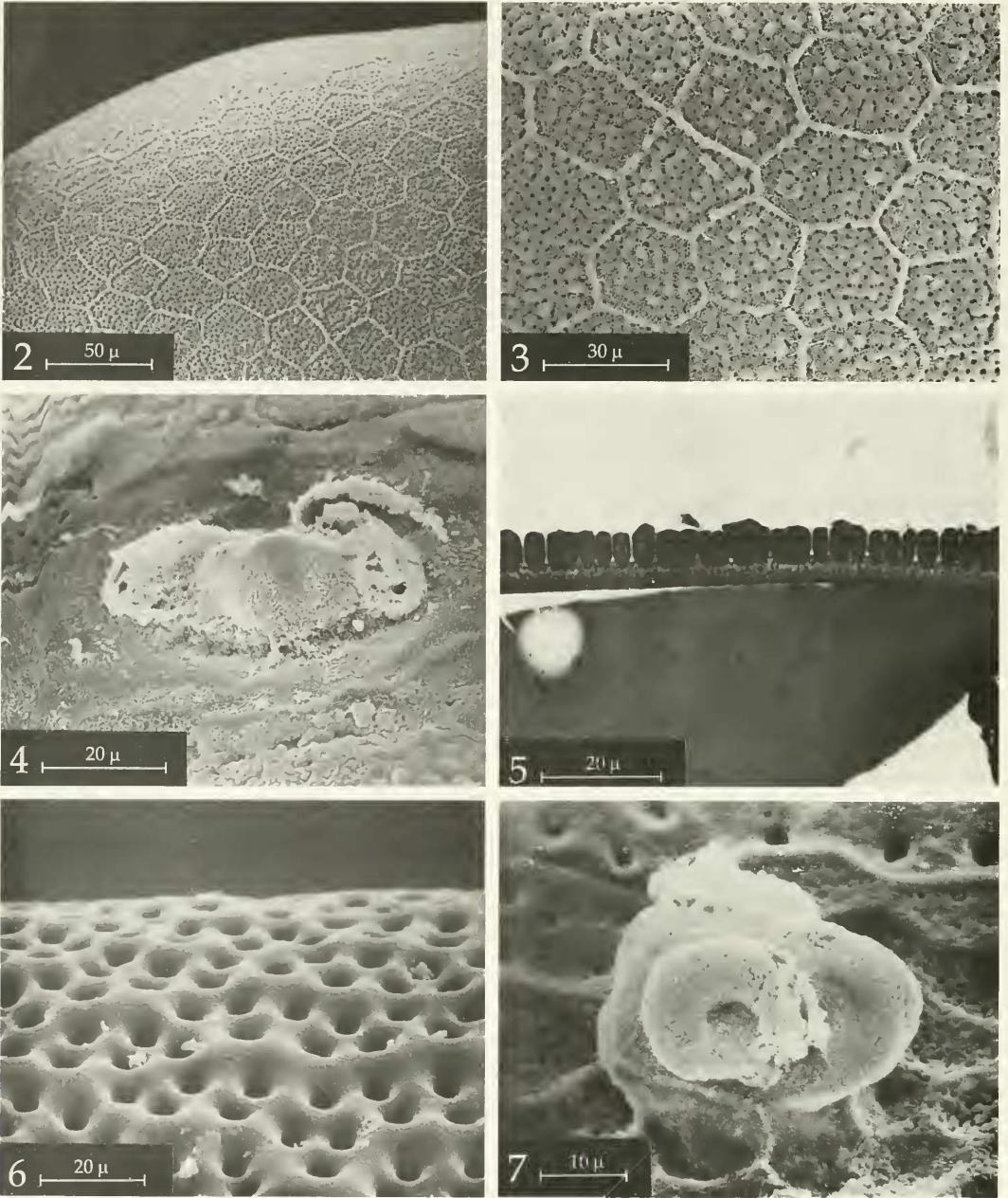
##### *Ambrysus (Syncollus) circumcinctus* Montandon (Figs. 6-9)

*Ambrysus circumcinctus* Montandon 1910: 442-444.

USA: Texas, Kimble Co., Junction

Length,  $1.11 \pm 0.01$ ; width,  $0.48 \pm 0.01$ ;  $n = 10$ ; dissected.

Overall appearance elongate-oval. Reticulation pattern only faintly visible as impressed lines. Within each unit formed by

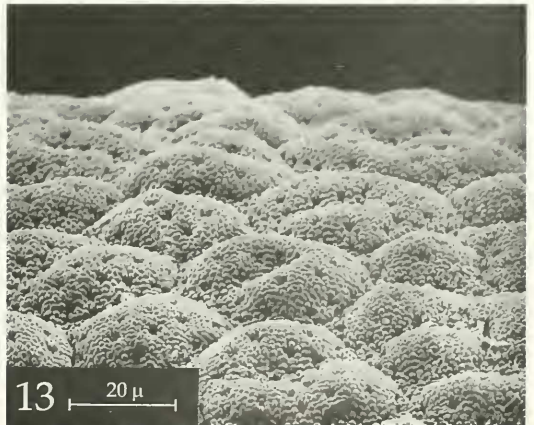
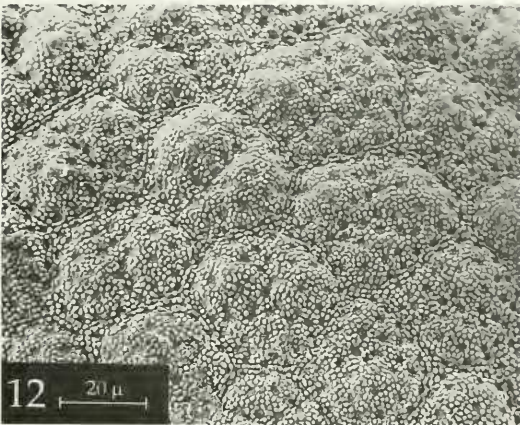
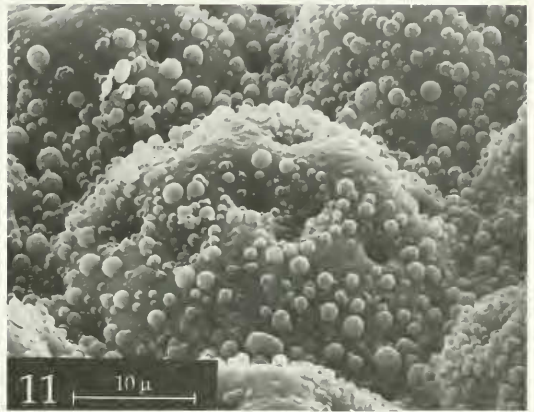
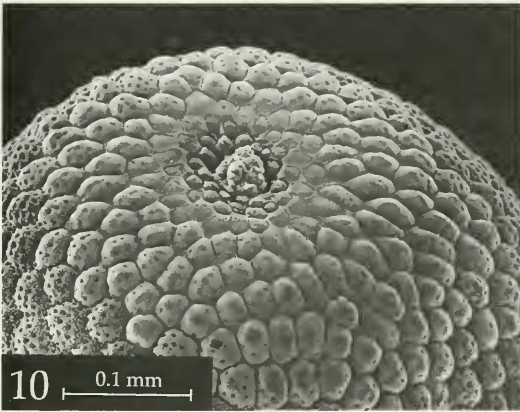
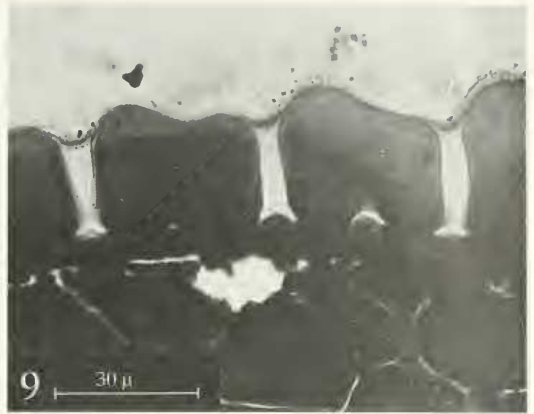


Figs. 2-7. 2-5, *Ambrysus funebris*. 2, 3, Chorion surface. 4, Micropylar plug. 5, Chorion section. 6, 7, *A. circumcinctus*. 6, Chorion surface. 7, Micropylar plug.

pattern, 5-8 aeropyles set in deep individual sockets (Fig. 6). Anterior pole with reticulation pronounced with raised lines and with aeropyles absent. Micropylar plug at anterior pole, ovate, and with two distinct, lateral helical micropylar tubes (Fig. 7).

Section through base of micropylar plug with two micropyles (Fig. 8). Protuberances other than micropyle lacking.

Exochorion ca. 4 × thicker than endochorion. Pore canals widest at base (Fig. 9).



Figs. 8-13. 8, 9, *Ambrysus circumcinctus*. 8, Micropyle section at base of plug. 9, Chorion section. 10, 11, *A. montandoni*. 10, Anterior pole with micropylar plug. 11, Chorion surface. 12, 13, *A. arizonus*, chorion surface.

*Ambrysus (Syncollus) montandoni* La Rivers  
(Figs. 10, 11)

*Ambrysus montandoni* La Rivers 1963: 1-5. VENEZUELA: Territorio Amazonas, Tobogan

Length, 1.34; width, 0.64; n = 1; dissected.

Overall appearance elongate-oval. Reticulation pattern generally consisting of tetragonal to heptagonal units, delimited by sulci between adjacent hemispherical, furuncular mounds (Fig. 10). Within each

unit, 15–30 aeropyles, becoming less distinct toward anterior pole. Aeropyles in sulci as well as on mounds. Numerous globules adhered to surface (Fig. 11). (Although these globules may be artifacts, they were persistent even after sonication in 100% acetic acid.) Reticulation less conspicuous anteriorly because mounds become flattened until immediate vicinity of micropyle where smaller reticulation units are evident (Fig. 10). Micropylar plug at anterior pole and amorphous. Protuberances other than micropyle, mounds, and granules lacking.

*Ambrysus (Ambrysus) arizonus* La Rivers  
(Figs. 12–15)

*Ambrysus arizonus* La Rivers 1951: 320–322.

USA: Arizona, Gila Co., Jakes Corner  
Length,  $1.45 \pm 0.01$ ; width,  $0.77 \pm 0.01$ ;  $n = 8$ ; oviposited.

Overall appearance elongate-oval. Reticulation generally consisting of pentagonal to heptagonal units, delimited by depressions. Each depression with double row of elongate papillae defining unit boundaries (Fig. 12). Within each unit, chorion raised and coarsely papillose (Fig. 13). Aeropyles indistinct, evident as pitted appearance among papillae; number 20–50 per cell. Tubercles lacking. Anterior pole with reticulation and papillae less distinct. Micropylar plug amorphous; section through base of micropylar plug with two micropyles (Fig. 14).

Exochorion distinctly thicker than endochorion. Pore canals widest in basal third (Fig. 15).

*Ambrysus (Ambrysus) buenoi* Usinger  
(Figs. 16, 17)

*Ambrysus buenoi* Usinger 1946: 199–200.

USA: Texas, Kimble Co., Junction  
Length,  $1.32 \pm 0.02$ ; width,  $0.65 \pm 0.02$ ;  $n = 11$ ; oviposited.

Overall appearance elongate-oval. Surface comprising a series of anastomosing mounds with irregularly produced protuber-

ances (Fig. 16). Bases of mounds with large aeropyles distributed randomly. Chorionic surface, including swells and protuberances, granular (Fig. 17). Micropyle amorphous. Chorionic surface immediately surrounding micropyle lacking regular surface features, although poorly defined mounds may occur.

*Ambrysus (Ambrysus) crenulatus*  
Montandon  
(Figs. 18, 19)

*Ambrysus crenulatus* Montandon 1897a: 13–14.

ECUADOR: Napo Province, Puerto Napo  
Length,  $1.12 \pm 0.01$ ; width,  $0.49 \pm 0.01$ ;  $n = 10$ ; dissected.

Overall appearance elongate-oval. Reticulation generally consisting of pentagonal to heptagonal units, delimited by distinctly raised, thin walls (Fig. 18). Each unit appearing as a deep socket, with approximately 8–17 large, irregularly distributed aeropyles (Fig. 19). Tubercles lacking. Anterior pole with reticulation less distinct. Micropylar plug amorphous. Protuberances other than micropyle and raised reticulation lacking.

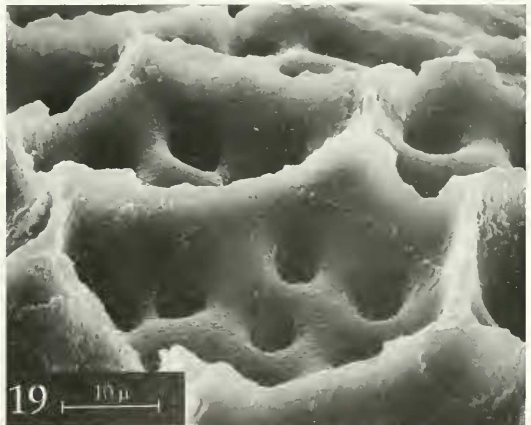
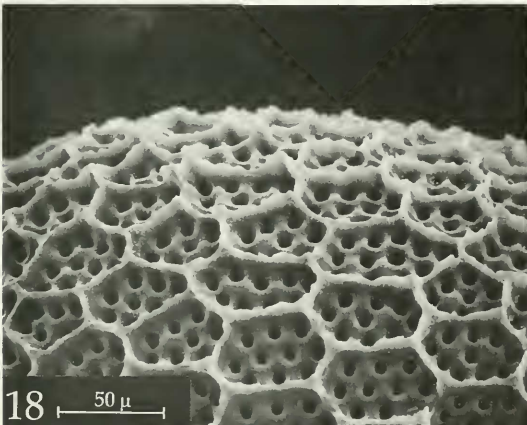
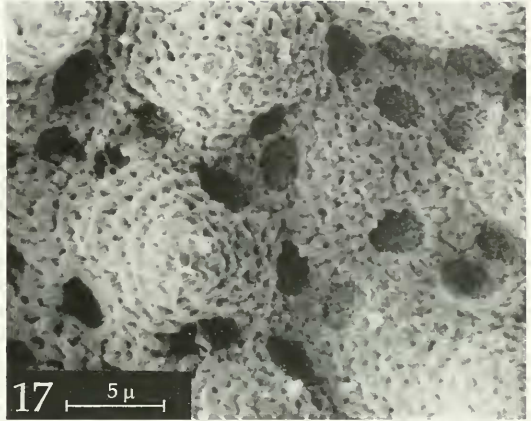
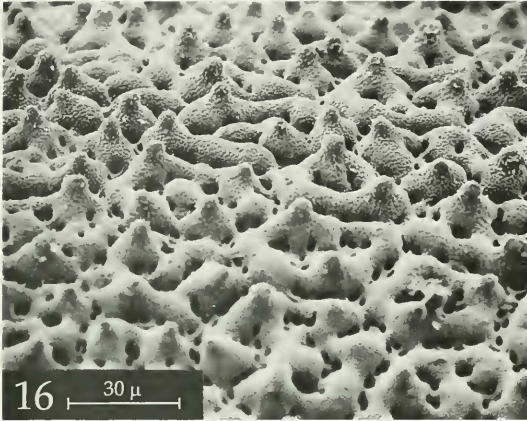
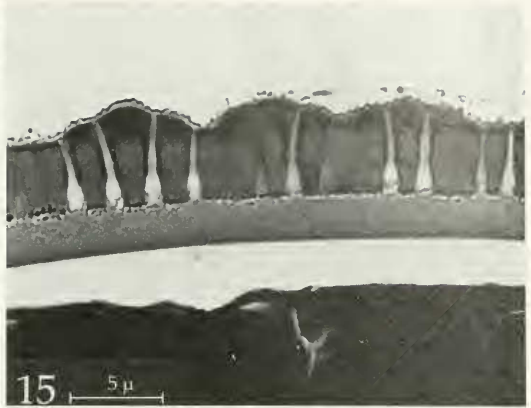
*Ambrysus (Ambrysus) fossatus* Usinger  
(Figs. 20, 21)

*Ambrysus fossatus* Usinger 1946: 191–192.  
ECUADOR: Napo Province, Puerto Napo  
Length,  $1.23 \pm 0.03$ ; width,  $0.57 \pm 0.02$ ;  $n = 3$ ; dissected.

Overall appearance elongate-oval. Reticulation pattern generally consisting of pentagonal to heptagonal units and only faintly visible (Fig. 20). Within each unit, 10–20 conspicuous aeropyles. Chorionic surface devoid of protruberances other than micropyle. Middle of pore canals generally parallel-sided (Fig. 21). Micropylar plug amorphous, acentric.

*Ambrysus (Ambrysus) hungerfordi* Usinger  
(Figs. 22–25)

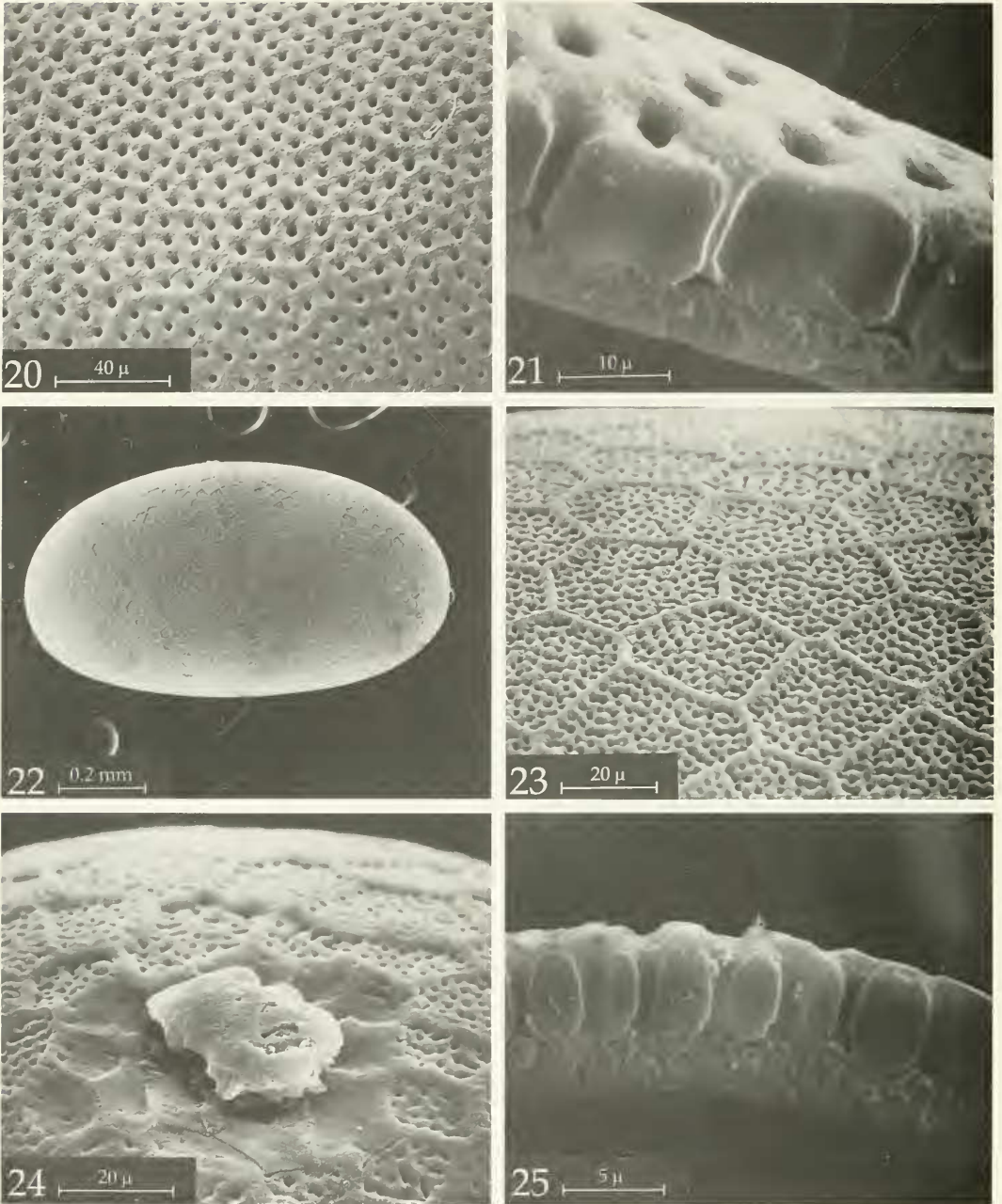
*Ambrysus hungerfordi* Usinger 1946: 192–194.



Figs. 14–19. 14, 15, *Ambrysus arizonus*. 14, micropyle section at base of plug. 15, Chorion section. 16, 17, *A. buenoi*, chorion surface. 18, 19, *A. crenulatus*, chorion surface.

USA: Texas, Presidio Co., Big Bend Ranch State Natural Area  
 Length,  $1.18 \pm 0.01$ ; width,  $0.63 \pm 0.01$ ;  $n = 9$ ; dissected.

Overall appearance oval (Fig. 22). Reticulation pattern generally consisting of pentagonal to heptagonal units, delimited by low, raised ridges (Fig. 23). Within each

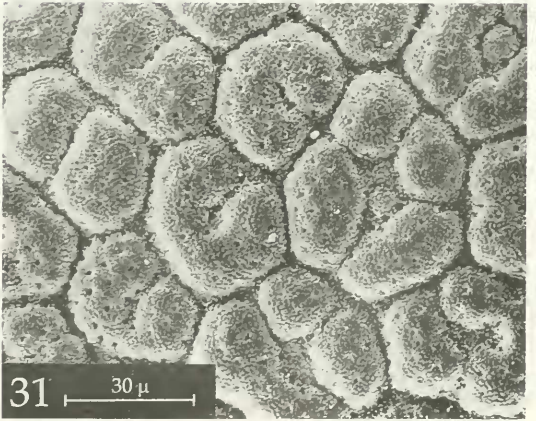
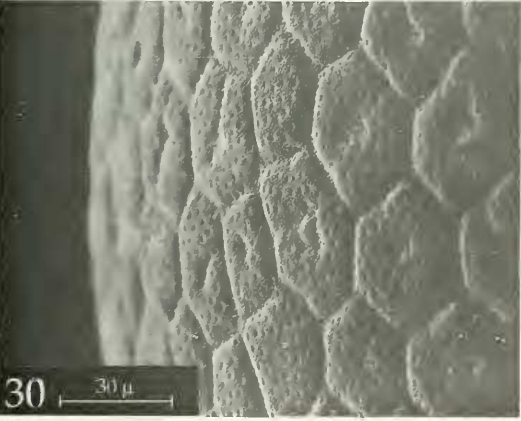
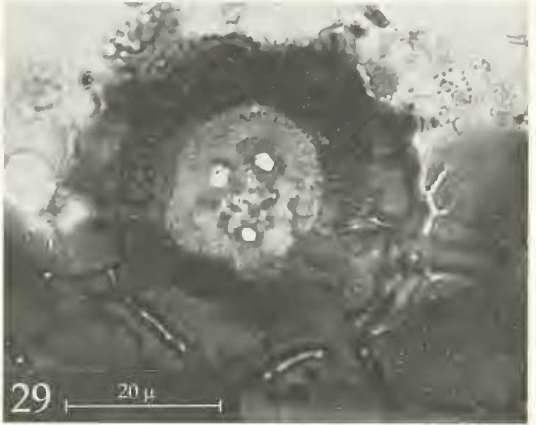
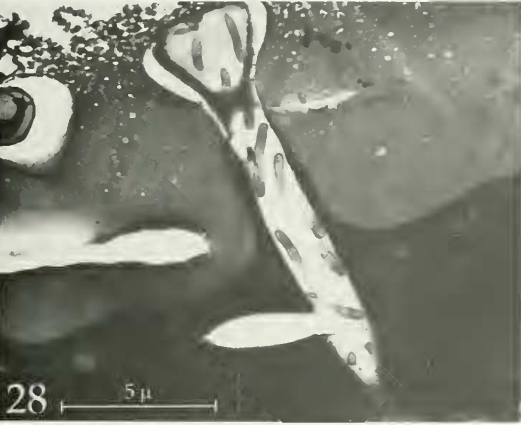
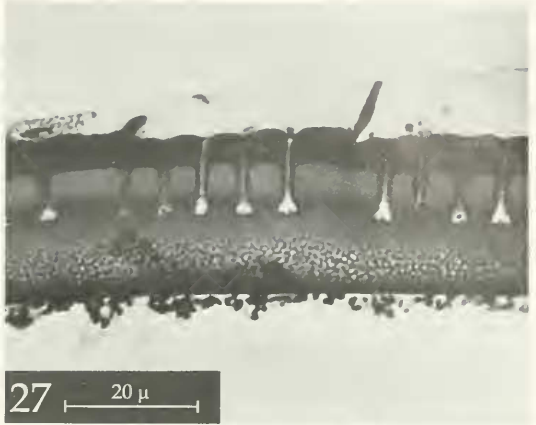
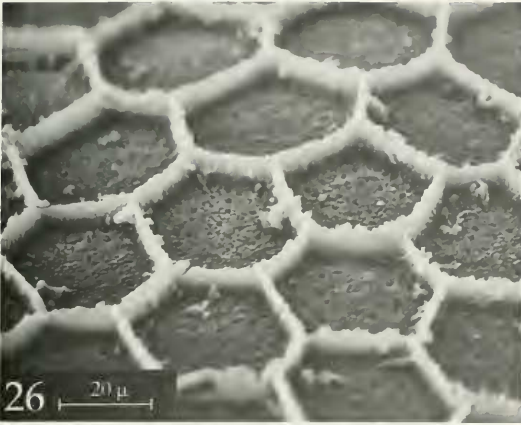


Figs. 20–25. 20, 21, *Ambrysus fossatus*. 20, Choron surface. 21, Choron section. 22–25, *A. hungerfordi*. 22, Whole egg. 23, Choron surface. 24, Micropylar plug. 25, Choron section.

unit, 50–120 aeropyles more or less evenly distributed. Protruberances, tubercles, and papillae lacking. Micropylar plug anterior and amorphous (Fig. 24). Anterior pole

with reticulation less pronounced, aeropyles fewer. Chorionic inner layer 60% as thick as chorionic outer layer (Fig. 25). Pore canals narrowest at middle.





Figs. 26–31. 26, *Ambrysus inflatus*, chorion surface. 27–29, *A. lunatus*. 27, Chorion section. 28, Pore canal containing bacteria. 29, Micropyle section at base of plug. 30, 31, *A. mormon*, chorion surface.

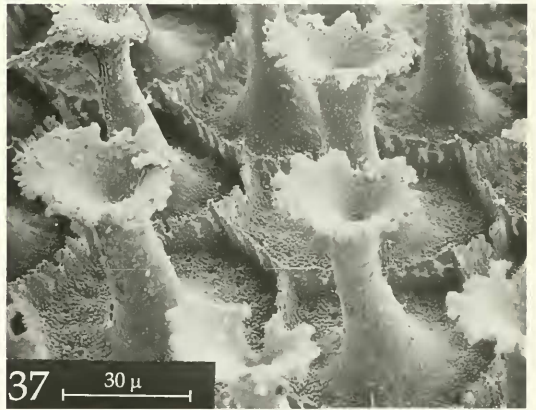
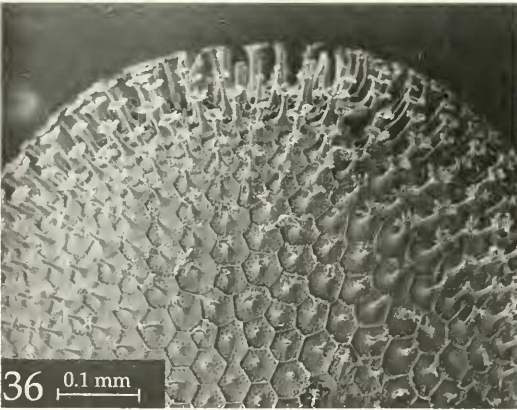
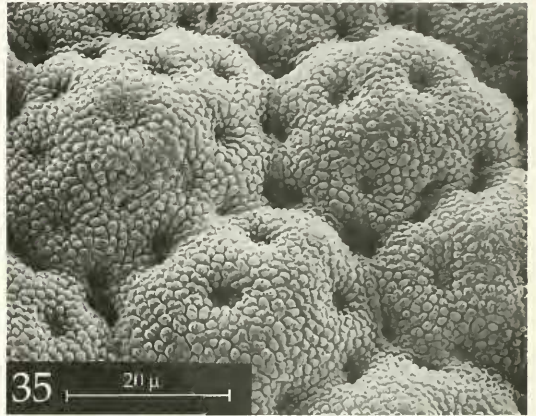
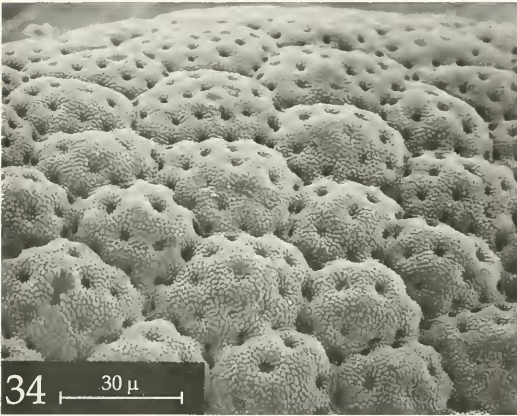
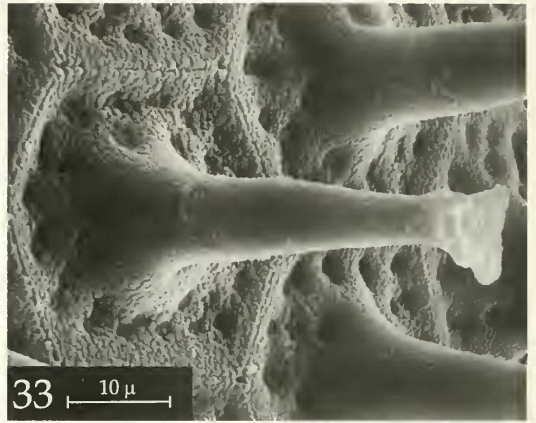
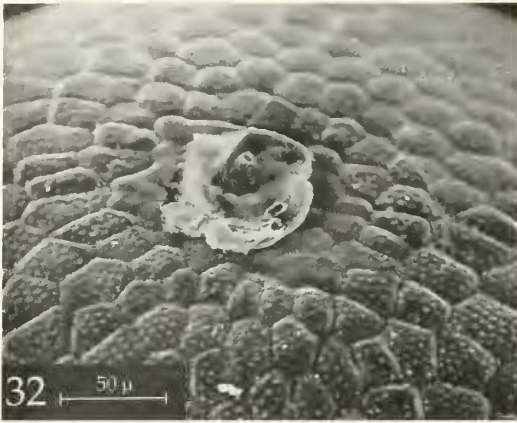
*Ambrysus (Ambrysus) inflatus* La Rivers  
(Fig. 26)

*Ambrysus inflatus* La Rivers 1953a: 1316–1318.

MEXICO: Jalisco, Chapala

Length,  $1.37 \pm 0.01$ ; width,  $0.68 \pm 0.01$ ;  $n = 10$ ; dissected.

Overall appearance elongate with rounded ends. Reticulation pattern generally consisting of pentagonal to heptago-



Figs. 32–37. 32, *Ambrysus mormon*, anterior pole with micropylar plug. 33, *A. occidentalis*, chorion surface with antheform processes. 34, 35, *A. plautus*, chorion surface. 36, 37, *A. portheo*. 36, Anterior pole. 37, Chorion surface with antheform processes.

nal units, delimited by a series of irregularly raised ridges with numerous tiny papillae between (Fig. 26). Scattered groups of papillae depressed, creating pitted appearance. Anterior pole with amorphous

micropylar plug, without raised reticulation or papillae.

The appearance of the chorion is virtually indistinguishable from that of *A. lunatus* Usinger (see Sites and Nichols 1990).

*Ambryus (Ambryus) lunatus* Usinger  
(Figs. 27–29)

*Ambryus lunatus* Usinger 1946: 203–205.

*Ambryus lunatus*: Sites and Nichols 1990: 800–808.

USA: Texas, Kimble Co., Junction

Endochorion subequal to exochorion in thickness (Fig. 27). Pore canals parallel-sided and widest at base. Presence of bacteria in pore canals as detected by transmission electron microscopy (Fig. 28). Micropylar plug with three micropyles (Fig. 29).

Original description of egg was given by Sites and Nichols (1990).

*Ambryus (Ambryus) mormon* Montandon  
(Figs. 30–32)

*Ambryus mormon* Montandon 1909: 48–49.

*Ambryus mormon*: Usinger 1946: 186–187, Plate X.

USA: New Mexico, Lincoln Co., Hondo  
Length,  $1.70 \pm 0.03$ ; width,  $0.98 \pm 0.02$ ;  $n = 6$ ; oviposited.

Overall appearance elongate-oval. Reticulation pattern generally consisting of tetragonal to heptagonal units, delimited by a series of depressions between composite tumescences (Fig. 30). Tumescences rarely entire, usually completely or incompletely divided into two to four components, occasionally with a smaller, central tumescence or depression (Fig. 31). Tumescences, depressions, including reticulation, covered with papillae. Aeropyles generally distributed, neither clustered nor concentrated. Tumescences becoming flatter and less divided toward anterior pole. Micropylar plug amorphous, acentric (Fig. 32).

Usinger (1946) indicated that eggs are glued to the surface of pebbles and are sub-oval with a buttonlike micropyle at the anterior pole.

*Ambryus (Ambryus) occidentalis* La  
Rivers  
(Fig. 33)

*Ambryus occidentalis* La Rivers 1951: 322–325.

USA: Arizona, Gila Co., Jakes Corner  
Length,  $1.28 \pm 0.01$ ; width,  $0.62 \pm 0.00$ ;  $n = 3$ ; dissected.

Overall appearance elongate-oval. Reticulation pattern generally consisting of hexagonal units, delimited by raised boundaries. Single antheform process extending outward from center of each unit, distal end concave and expanded (Fig. 33). Margins surrounding distal concavity irregular, never in contact with adjacent antheform process. Base of antheform process widest, gradually narrowing distally. Papillae covering surface from raised reticulation to base of antheform process. 25–40 irregularly distributed aeropyles distinctly visible around base of antheform process. Anterior pole with micropylar plug, with pattern less distinct, antheform processes and papillae absent.

*Ambryus (Ambryus) plautus* Polhemus  
and Polhemus  
(Figs. 34, 35)

*Ambryus plautus* Polhemus and Polhemus 1982: 326–328.

MEXICO: Chihuahua, Cusarare

Length,  $1.12 \pm 0.01$ ; width,  $0.54 \pm 0.02$ ;  $n = 3$ ; dissected.

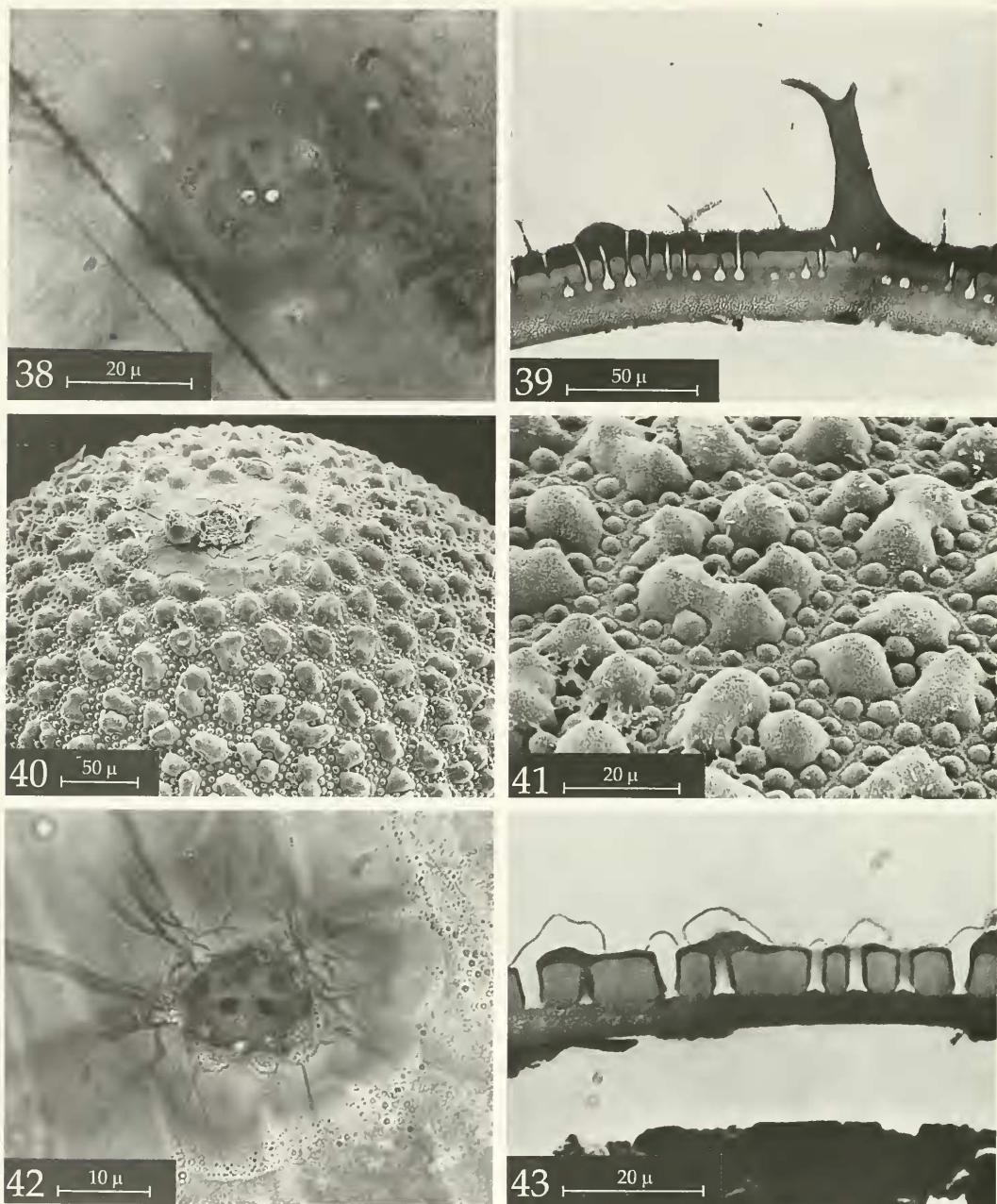
Overall appearance elongate-oval. Reticulation pattern generally consisting of pentagonal to heptagonal units, delimited by depressed lines. Within each unit, chorion raised and distinctly papillose (Fig. 34). Aeropyles large, distinct; number 3–12 in interior of unit, 10–18 in depressed perimeter of unit (Fig. 35). Tubercles lacking. Anterior pole with pattern and papillae less distinct. Micropylar plug amorphous.

*Ambryus (Ambryus) portheo* La Rivers  
(Figs. 36–39)

*Ambryus portheo* La Rivers 1953a: 1320–1321.

MEXICO: Nuevo Leon, La Nogalera

Length,  $1.56 \pm 0.02$ ; width,  $0.89 \pm 0.01$ ;  $n = 2$ ; oviposited.



Figs. 38–43. 38, 39, *Ambrysus portheo*. 38, Micropyle section at base of plug. 39, Chorion section. 40–43, *A. pudicus*. 40, Anterior pole with micropylar plug (dislodged). 41, Chorion surface. 42, Micropyle section at base of plug. 43, Chorion section.

General appearance robust with apices slightly truncate (Fig. 36). Reticulation pattern generally consisting of pentagonal to hexagonal units, delimited by raised, fence-like boundaries. Ectal edge of

boundary with irregularly-spaced, deep notches extending ca.  $\frac{1}{5}$  distance to base. Single antheform process extending outward from center of each unit, the distal end of which is concave and expanded

(Fig. 37). Margins surrounding distal concavity irregular, never in contact with adjacent antheform process. Base of antheform process widest, gradually narrowing distally. Papillae covering surface between unit boundaries and base of antheform process. Irregularly spaced aeropyles occasionally visible in gaps between papillae. Anterior pole with pattern reduced around micropylar plug, antheform processes and papillae absent. Micropylar plug with two micropyles (Fig. 38)

Exochorion slightly thicker than endochorion. Pore canals bulbous at base. Antheform processes solid, without ducts (Fig. 39).

*Ambrysus (Ambrysus) pudicus* Stål  
(Figs. 40–43)

*Ambrysus pudicus* Stål 1862: 460.

USA: Texas, Kimble Co., Junction

Length,  $1.12 \pm 0.01$ ; width,  $0.61 \pm 0.01$ ;  $n = 11$ ; oviposited.

Overall appearance elongate-oval. Reticulation pattern generally consisting of pentagonal to heptagonal units, delimited by slightly raised boundaries (Fig. 40). Within each unit, protuberances of two sizes: larger tubercles and smaller pustules (Fig. 41). Perimeter of each unit with a series of ca. 12–25 pustules; additional pustules usually near center of unit and among tubercles. Tubercles number 1–5 per unit and situated near center, occasionally surrounding one or more pustules. Outline of pustules round, of tubercles amoebiform. Anterior pole with pattern faintly visible, protuberances other than micropyle lacking. Micropylar plug amorphous, acentric, with two micropyles (Fig. 42).

Exochorion thicker than endochorion (Fig. 43). Pore canals wide, ca.  $0.4 \times$  length.

*Ambrysus (Ambrysus) pulchellus*  
Montandon  
(Figs. 44, 45)

*Ambrysus pulchellus* Montandon 1897a: 16.

USA: Texas, Kimble Co., Junction

Length,  $1.36 \pm 0.02$ ; width,  $0.65 \pm 0.01$ ;  $n = 11$ ; oviposited.

General appearance elongate-oval with rounded apices. Reticulation pattern generally consisting of pentagonal to heptagonal units, delimited by sulci between tumescences (Fig. 44). Each tumescence extends around perimeter of unit and abuts adjacent tumescences (Fig. 45). Single, smaller, irregularly-shaped tumescence within each perimeter tumescence. Occasionally, central tumescence absent, replaced by depression near center. Tumescences generally glabrous. Clusters of approximately 12–20 aeropyles distributed over surface of tumescences, concentrated near margins. Micropylar plug slightly acentric and amorphous.

*Ambrysus (Ambrysus) puncticollis* Stål  
(Figs. 46–48)

*Ambrysus puncticollis* Stål 1876: 143.

USA: Texas, Kimble Co., Junction

Length,  $1.36 \pm 0.01$ ; width,  $0.66 \pm 0.01$ ;  $n = 11$ ; oviposited.

Overall appearance elongate-oval. Reticulation pattern generally consisting of pentagonal to heptagonal units, delimited by depressed lines (Fig. 46). Within each unit, 20–80 large aeropyles (aeropyles filled with debris in SEMs) (Fig. 47). Protruberances, tubercles, and papillae lacking. Micropylar plug anterior and amorphous. Anterior pole with pattern less distinct.

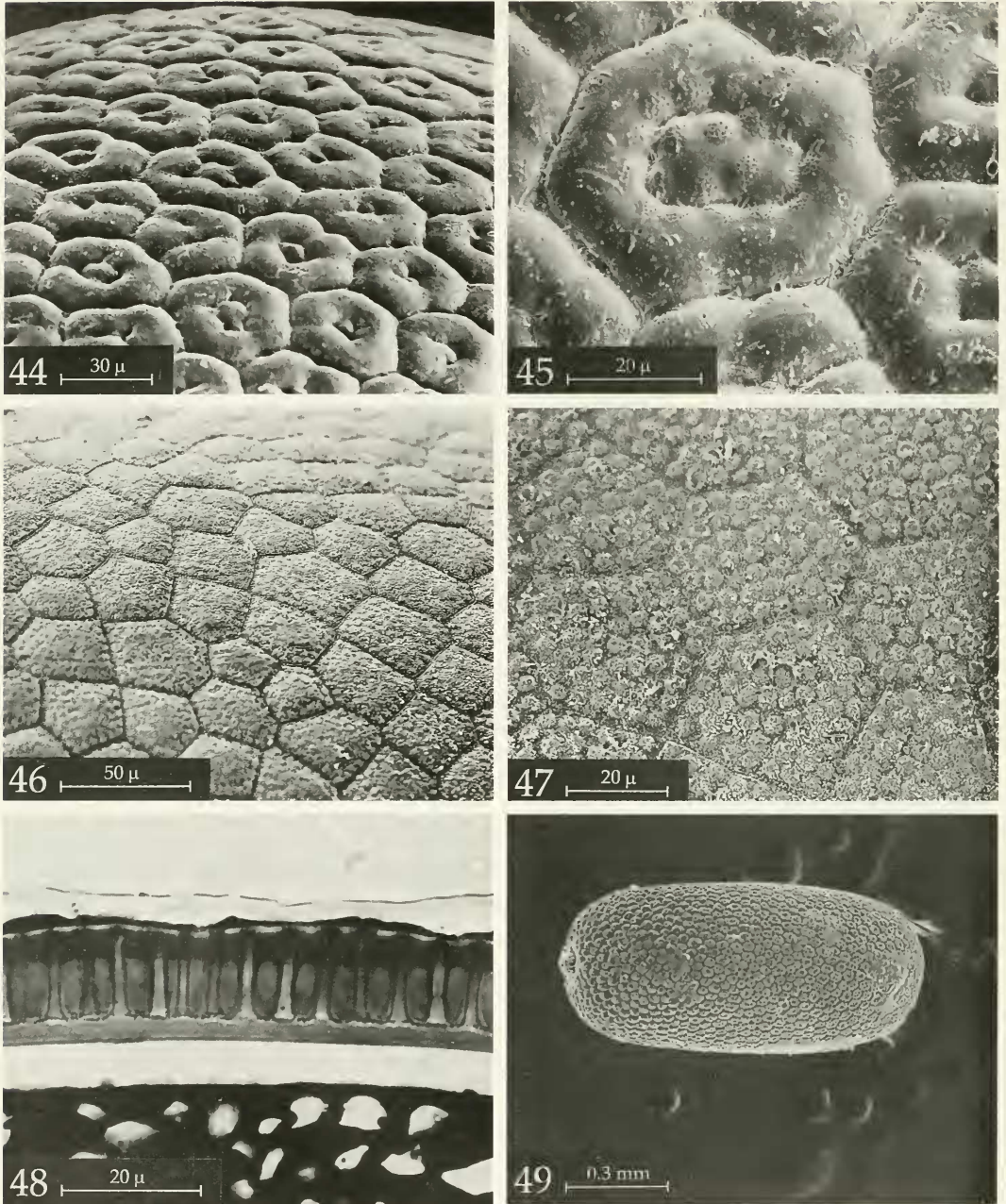
Exochorion ca.  $4.5 \times$  thicker than endochorion (Fig. 48). Pore canals slightly divergent entally and occur at somewhat regular interval.

*Ambrysus (Ambrysus) spiculus* Polhemus  
and Polhemus  
(Figs. 49–51)

*Ambrysus spiculus* Polhemus and Polhemus  
1981: 400–401.

MEXICO: Chihuahua, Rio Concheño

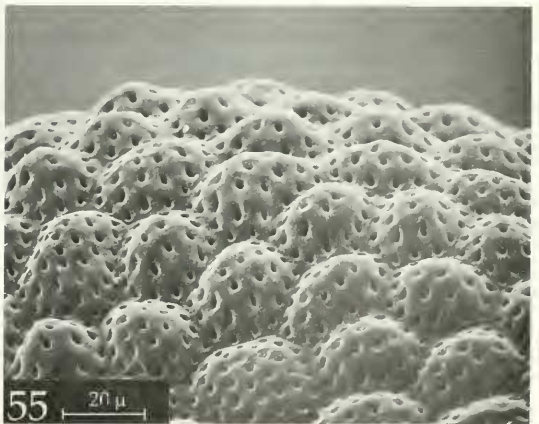
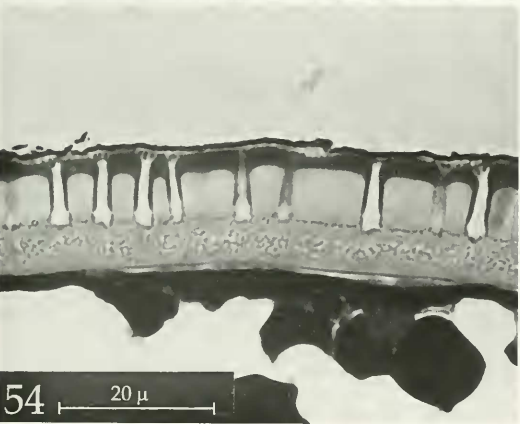
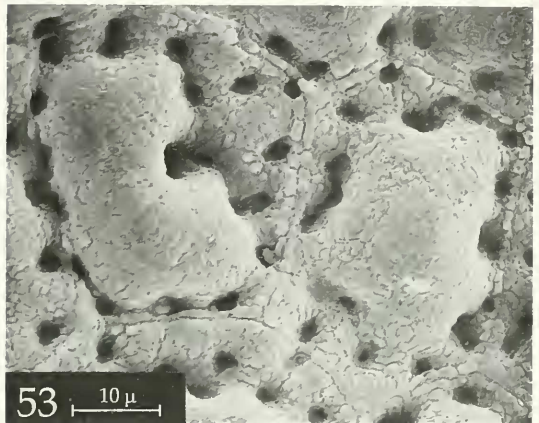
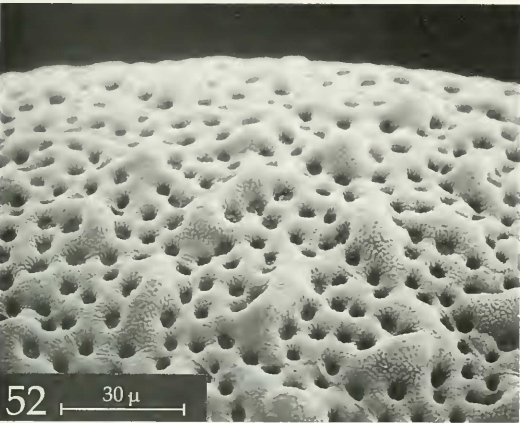
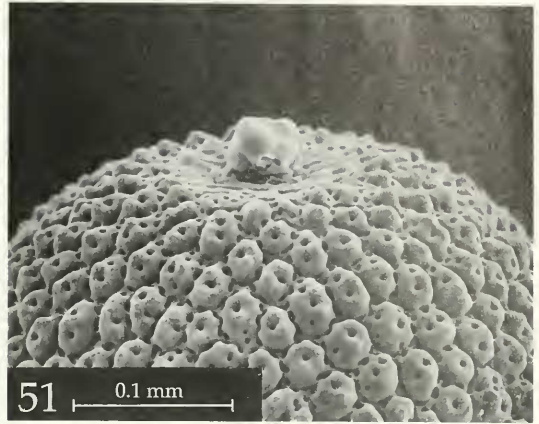
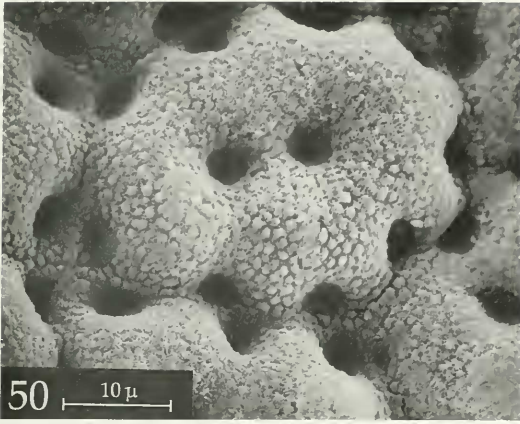
Length,  $1.10 \pm 0.01$ ; width,  $0.48 \pm 0.03$ ;  $n = 3$ ; dissected.



Figs. 44-49. 44, 45, *Ambrysus pulchellus*, chorion surface. 46-48, *A. puucticollis*. 46, 47, Chorion surface. 48, Chorion section. 49, *A. spiculus*, whole egg.

Overall appearance elongate-oval (Fig. 49). Reticulation pattern generally consisting of pentagonal to heptagonal units, delimited by depressed boundaries. Within each unit, chorion raised and finely papil-

lose (Fig. 50). Perimeter of each unit with 8-16 large, distinct aeropyles; near the center of unit 1-4 aeropyles. Anterior pole with reticulation and papillae less evident. Micropylar plug amorphous (Fig. 51).



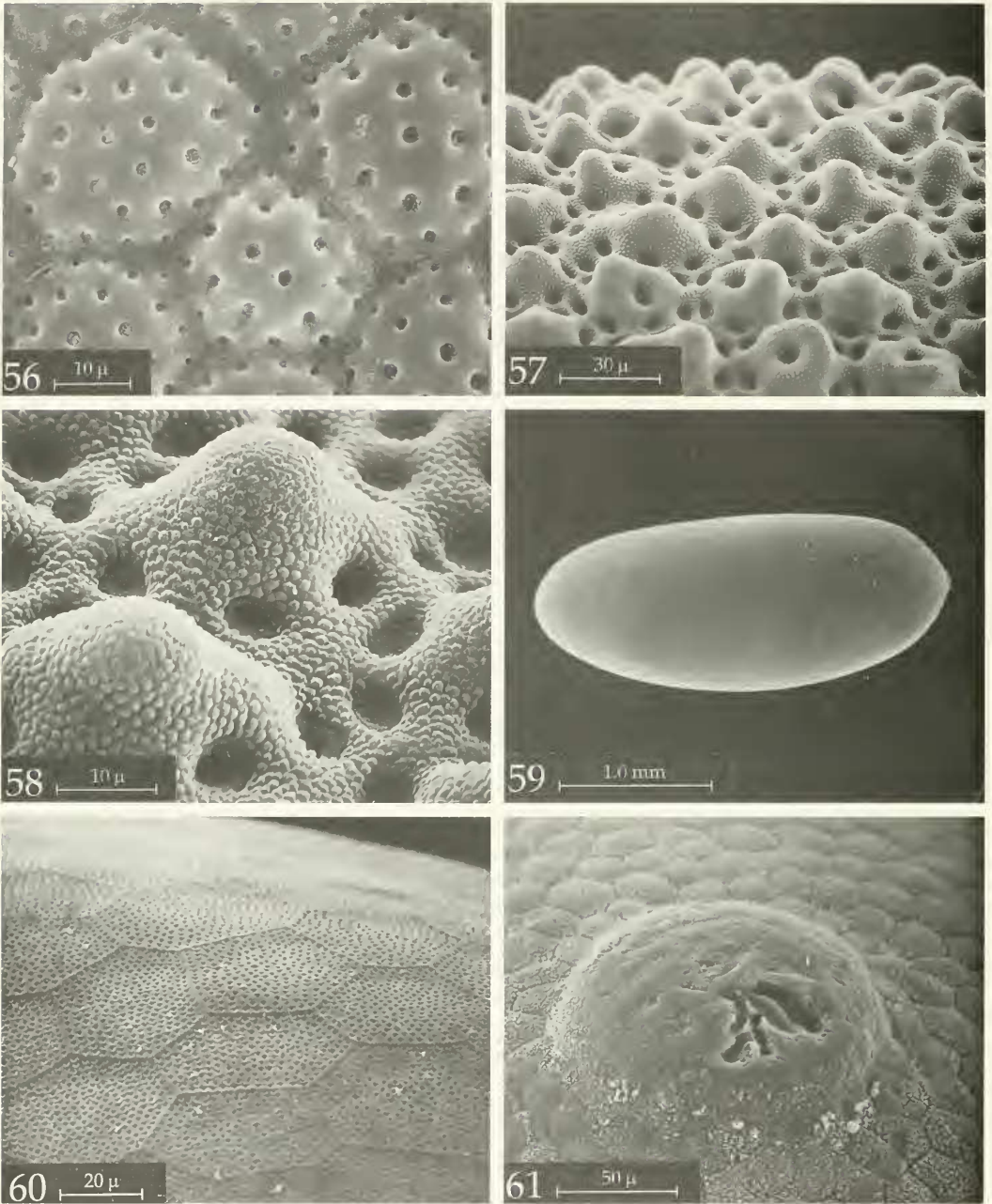
Figs. 50–55. 50, 51. *Ambrysus spiculus*. 50, Chorion surface. 51, Anterior pole with micropylar plug. 52–54, *A. thermarum*. 52, 53, Chorion surface. 54, Chorion section. 55, *A. tridentatus*, chorion surface.

*Ambrysus (Ambrysus) thermarum* La Rivers  
(Figs. 52–54)

*Ambrysus thermarum* La Rivers 1953b: 1–3.  
USA: New Mexico, Taos Co., Arroyo Hondo

Length,  $1.43 \pm 0.06$ ; width,  $0.72 \pm 0.02$ ;  $n = 10$ ; oviposited.

Overall appearance elongate-oval. Reticulation pattern generally consisting of pentagonal to heptagonal units, delimited by



Figs. 56–61. 56, *Ambrysus tridentatus*, chorial surface. 57, 58, *A. woodburyi*, chorial surface. 59–61, *Gestroiella linnocoroides*. 59, Whole egg. 60, Chorial surface. 61, Micropylar plug.

double row of rounded to elongate papillae (Fig. 52). Chorionic surface generally covered with papillae. Within each unit formed by reticulation, a single amorphous tumes-

cence (Fig. 53). Aeropyles distinct and randomly distributed on chorial surface except on tumescence; number 15–30 per unit. Pattern, tumescences, papillae, aeropyles becoming



less distinct toward anterior pole. Micropylar plug amorphous.

Exochorion slightly thicker than endochorion (Fig. 54). Pore canals widest at base.

*Ambrysus (Ambrysus) tridentatus* La Rivers  
(Figs. 55, 56)

*Ambrysus tridentata* La Rivers 1962: 129–132.

MEXICO: Nuevo Leon, Potrero Redondo  
Length, 1.14; width, 0.58; n = 1; dissected.

Overall appearance elongate-oval. Reticulation pattern generally consisting of pentagonal to heptagonal units, delimited by depressed boundaries. Chorion domed within each unit (Fig. 55). Aeropyles sub-circular near center of dome, ellipsoid off-center; 20–40 per cell. Chorion smooth; papillae and tubercles lacking (Fig. 56). Anterior pole with domes diminishing in size, aeropyles becoming less evident. Micropylar plug amorphous.

*Ambrysus (Ambrysus) woodburyi* Usinger  
(Figs. 57, 58)

*Ambrysus woodburyi* Usinger 1946: 194–195.

USA: Arizona, Cochise Co., Portal  
Length, 1.16 ± 0.02; width, 0.57 ± 0.02; n = 10; oviposited.

Overall appearance elongate-oval. Reticulation pattern generally poorly-defined. Within each unit formed by reticulation, a single amorphous tumescence (Fig. 57). Each unit with approximately 7–12 large, distinct aeropyles randomly distributed around the tumescence. Chorionic surface generally finely papillose (Fig. 58). Anterior pole with tumescences and papillae less developed. Micropylar plug amorphous, acentric.

Subfamily Cheirochelinae Montandon  
1897b

Genus *Gestroiella* Montandon 1897b  
*Gestroiella limnocoroides* Montandon  
(Figs. 59–61)

*Gestroiella limnocoroides* Montandon  
1897b: 371–372.

THAILAND: Chiang Mai Prov., Chiang Mai

Length, 3.04 ± 0.02; width, 1.35 ± 0.02; n = 4; dissected.

Overall appearance elliptical with poles slightly acuminate (Fig. 59). Reticulation pattern generally consisting of pentagonal to octagonal units, delimited by low, elevated ridges (Fig. 60). Within each unit, 300–800 aeropyles. Micropyles incorporated into low, broad mound at anterior pole (Fig. 61). Other than micropyle, protruberances, tubercles, and papillae lacking.

Subfamily Aphelocheirinae Fieber 1851  
Genus *Aphelocheirus* Westwood 1833  
*Aphelocheirus femoratus* Polhemus and  
Polhemus  
(Figs. 62–64)

*Aphelocheirus femoratus* Polhemus and  
Polhemus 1988: 214–216.

THAILAND: Songkhla Prov., Ton Nga  
Chang National Park

Length, 1.13 ± 0.01; width, 0.51 ± 0.01; n = 10; dissected.

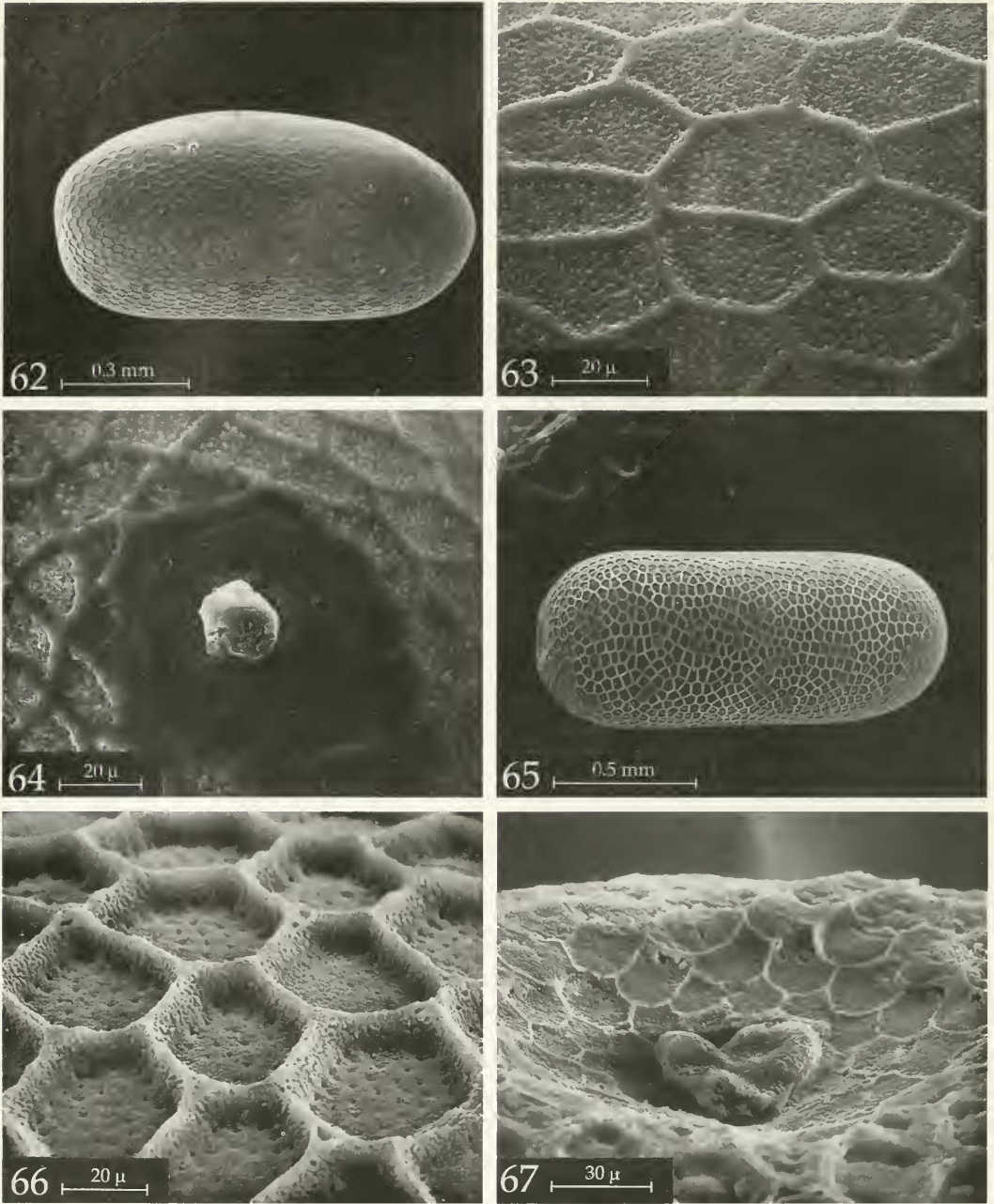
General appearance oval and robust with anterior pole slightly truncate (Fig. 62). Reticulation pattern generally consisting of pentagonal to heptagonal units, delimited by broad, slightly elevated ridges (Fig. 63). Within each unit, 100–300 aeropyles. Micropyle amorphous (Fig. 64). Chorionic surface immediately surrounding micropyle lacking well-defined surface features. Other than micropyle, protruberances, tubercles, and papillae lacking.

Subfamily Laccocorinae Stål 1876  
Genus *Heleocoris* Stål 1876  
*Heleocoris ovatus* Montandon  
(Figs. 65–67)

*Heleocoris ovatus* Montandon 1897c: 451–452.

THAILAND: Yala Province, Than To,  
Banglang National Park

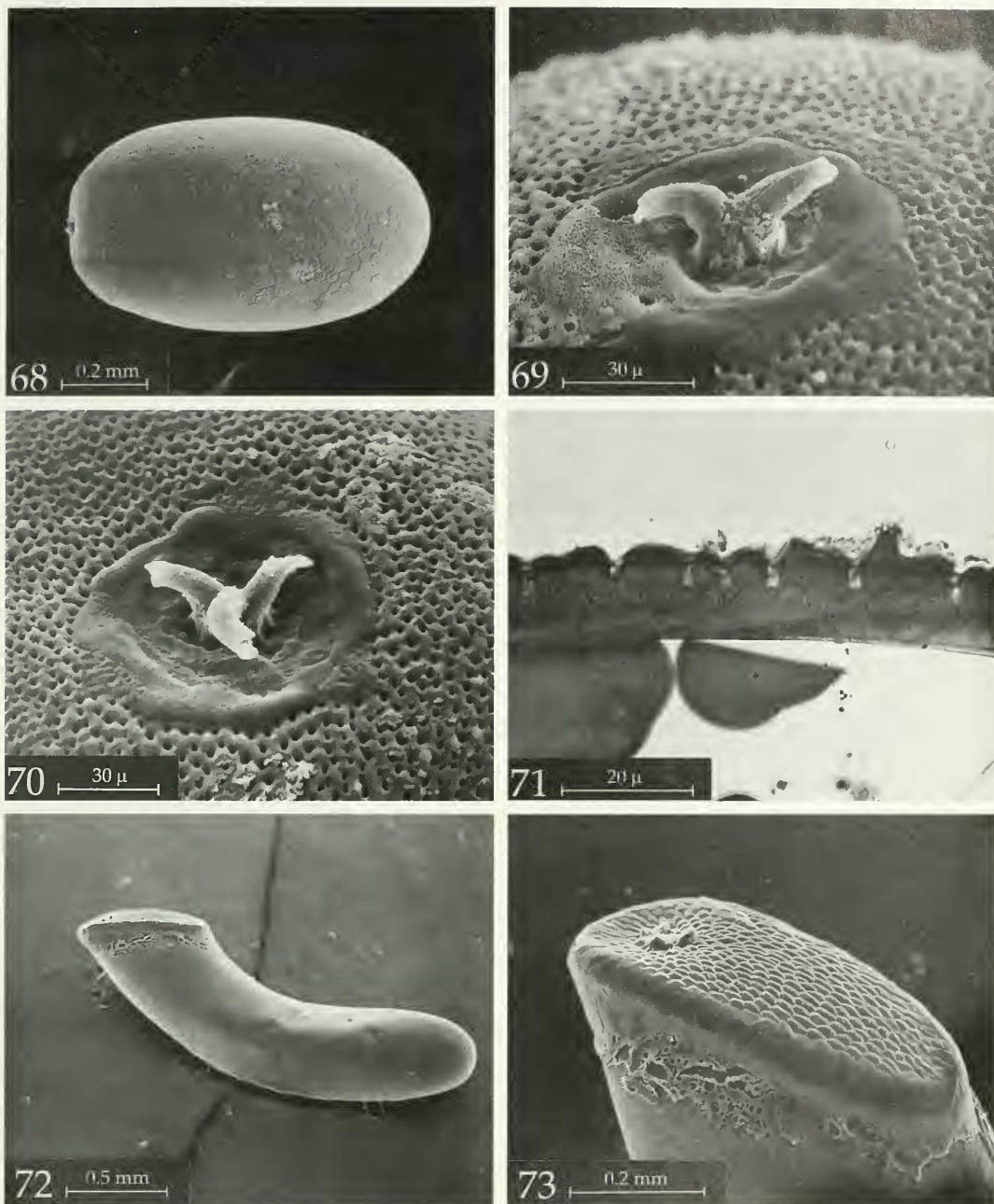
Length, 1.55 ± 0.01; width, 0.71 ± 0.01; n = 9; dissected.



Figs. 62–67. 62–64, *Aphelocheirus femoratus*. 62, Whole egg. 63, Chorion surface. 64, Anterior pole with micropylar plug. 65–67, *Heleocoris ovatus*. 65, Whole egg. 66, Chorion surface. 67, Micropylar plug in concavity at anterior pole.

Overall appearance elongate, parallel-sided with rounded ends (Fig. 65). Reticulation pattern generally consisting of tetragonal to heptagonal units, delimited by cos-

tiform ridges (Fig. 66). Within each unit, 25–75 aeropyles. Chorionic surface generally granular. Anterior pole with amorphous micropylar plug set in acetabular depression



Figs. 68-73. 68-71, *Linnocoris moapensis*. 68, Whole egg. 69, 70, Micropyles. 71, Chorion section. 72, 73, *Ilyocoris cimicoides*. 72, Whole egg. 73, Anterior pole.

(Fig. 67). Pattern in depression becoming indistinct toward micropyle.

Pending taxonomic revision, this species has been determined probably to be *H. ova-*

*tus*. Locality and ecological data associated with the collection of the adults from which eggs were obtained are available in Sites et al. (1997).

Subfamily Linnocorinae Stål 1876

Genus *Linnocoris* Stål 1858

*Linnocoris moapensis* (La Rivers)

(Figs. 68–71)

*Utingerina moapensis* La Rivers 1950: 368–373.

*Linnocoris moapensis*: Sites and Willig 1994: 810.

USA: Nevada, Clark Co., Moapa

Length,  $0.98 \pm 0.01$ ; width,  $0.56 \pm 0.01$ ;  $n = 8$ ; oviposited.

Overall appearance robust, elongate-oval (Fig. 68). Reticulation pattern generally consisting of pentagonal to heptagonal units, delimited by faintly impressed lines. Within each unit, chorion smooth, perforated by 15–60 aeropyles set in shallow individual sockets. Chorion smooth, devoid of papillae, tubercles, and protruberances other than micropyle. Anterior pole with micropyle set in concavity, immediately surrounded by modified chorion devoid of pattern and aeropyles. 2–3 distinct micropyles ( $\bar{v} = 2.8$ ,  $n = 10$ ) arising from central point, extending outward in arcuate fashion (Figs. 69, 70).

Exochorion ca.  $\frac{2}{3}$  as thick as endochorion. Pore canals widest at base (Fig. 71).

Subfamily Naucorinae Stål 1876

Genus *Ilyocoris* Stål 1861

*Ilyocoris cimicoides* (Linnaeus)

(Figs. 72–77)

*Nepa cimicoides* Linnaeus 1758: 440.

*Ilyocoris cimicoides*: Stål 1861: 201.

*Naucoris cimicoides*: Rawat 1939: 123–127, Figs. 1–3.

CZECHOSLOVAKIA: southern Bohemia, Veselnad Lu Nic

Length,  $2.25 \pm 0.05$ ; width,  $0.56 \pm 0.03$ ;  $n = 8$ ; dissected.

Overall appearance cylindrical and elongate with a 45 degree bend near middle (Fig. 72). Anterior pole flattened (Fig. 73), posterior pole rounded. Reticulation generally consisting of pentagonal to heptagonal units, delimited by faintly impressed boundaries (Fig. 74). Within each unit, cho-

riion smooth, perforated by 50–90 aeropyles. Flattened anterior pole with elongate tumescences radiating outward from acentric micropylar plug (Fig. 75). Micropylar plug with four micropyles (Fig. 76), each of which is raised slightly above the remainder of the plug (Fig. 77).

Rawat (1939) described the egg as approximately 2 mm in length and cylindrical with an operculate, recurved end. Lebrun (1960) illustrated the position of the micropylar plug on the operculum (although not labeled as such) and Hinton (1981) reported the presence of three to four micropyles. This is the only naucorid documented to have endophytic oviposition (Rawat 1939, Cobben 1968).

Genus *Pelocoris* Stål 1876

*Pelocoris femoratus* (Palisot de Beauvois)

(Figs. 78–81)

*Naucoris femorata* Palisot de Beauvois 1820: 237.

*Pelocoris femoratus*: Stål 1876: 144.

*Pelocoris femorata*: Torre Bueno 1903: 168–172.

*Pelocoris carolinensis*: Hungerford 1927: 80–82, Plate VI.

*Pelocoris femoratus*: McPherson et al. 1987: 291.

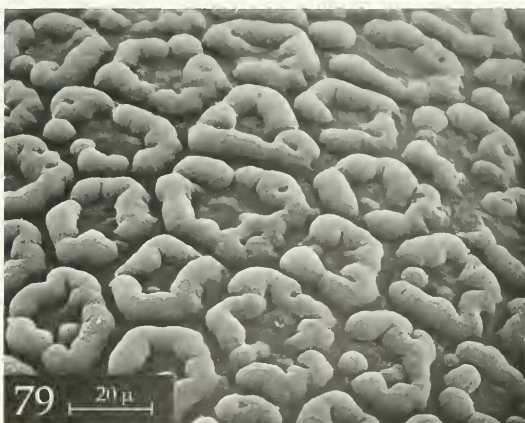
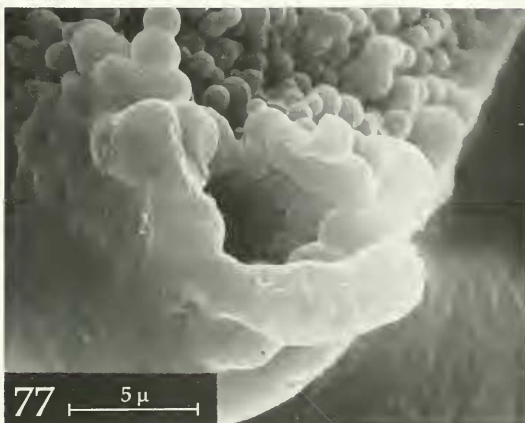
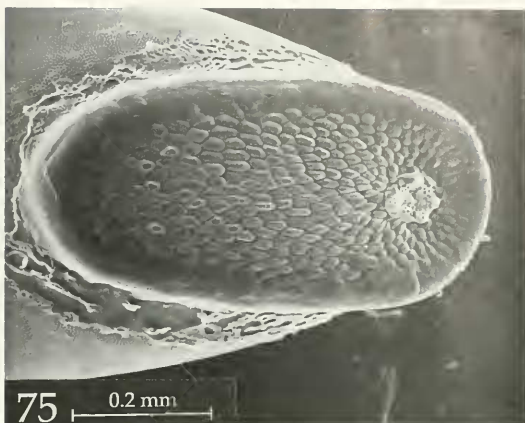
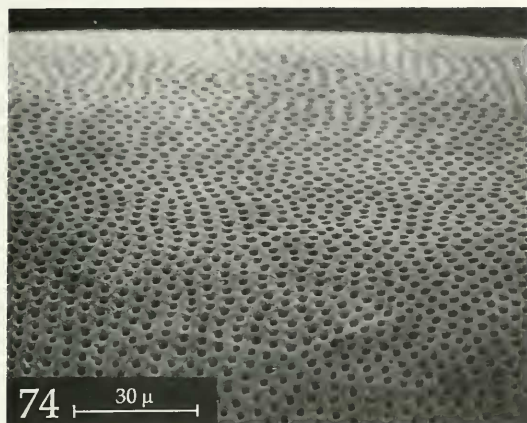
USA: Missouri, Boone Co., Columbia

Length,  $1.17 \pm 0.01$ ; width,  $0.64 \pm 0.01$ ;  $n = 10$ ; oviposited.

Overall appearance elongate-oval (Fig. 78). Reticulation pattern generally consisting of pentagonal to heptagonal units. Within each unit, irregular and sometimes discontinuous elongate tumescence approximating boundary (Fig. 79). Anterior pole with micropylar plug set in shallow concavity. Micropylar plug somewhat amorphous and inconsistent in appearance, with micropyles opening laterally (Fig. 80). Number of micropyles indistinct, but apparently 2–3.

Exochorion ca.  $3.5 \times$  thicker than endochorion. Pore canals widest at middle and base (Fig. 81).

Using light microscopy, McPherson et

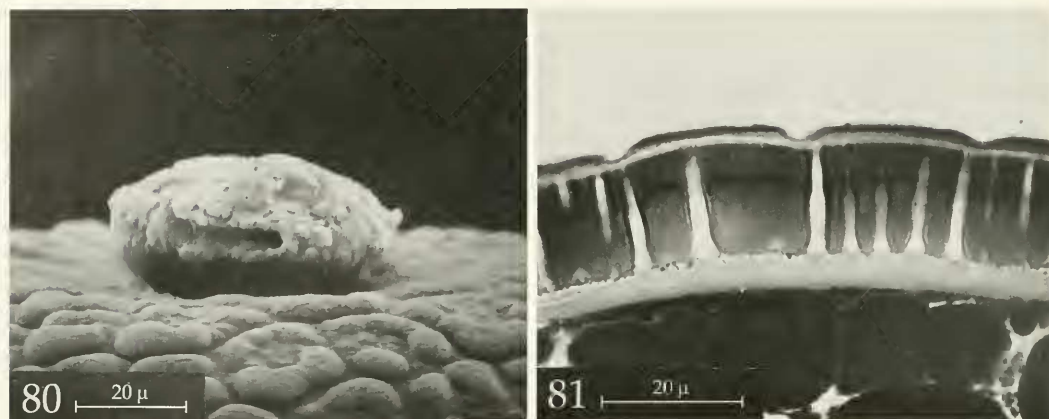


Figs. 74–79. 74–77, *Ilyocoris cimicoides*. 74, Chorion surface. 75, Anterior pole. 76, Micropylar plug. 77, Micropylar opening. 78, 79, *Pelocoris femoratus*. 78, Whole egg. 79, Chorion surface.

al. (1987) reported that the chorion has a primarily irregular hexagonal pattern and the micropylar plug is situated at the anterior end.

#### DISCUSSION

Differences were evident in the chorion between incompletely developed and well-



Figs. 80–81. *Pelocoris femoratus*. 80, Micropylar plug. 81, Chorion section.

developed eggs. Eggs that were incompletely developed generally appeared to have a single point within each reticulation unit, which was raised and around which the chorion appeared to have flowed down onto the surface of the egg. This 'poured' appearance probably represented the site of chorion deposition for each follicular epithelial cell. Nonetheless, for dissected eggs, even though we selected eggs from the common oviduct or vagina for descriptions, the possibility exists that egg structure may have continued to develop prior to oviposition. For the 21 species of *Ambrysus* examined, chorionic sculpturing differs interspecifically and generally is species-specific. Although these differences were noted, other specific features were common among some of the species.

Previously, eggs were described and electron micrographs presented for *A. lunatus* (Sites and Nichols 1990), a member of the *signoreti* group. Other members of the *signoreti* group represented here are *A. inflatus*, *A. occidentalis*, and *A. portheo*. Generally, these four species share egg features including an acutely raised, fence-like reticulation forming a polygonal pattern, and minute papillae distributed generally over the surface. In addition, two species possess elongate, antheform processes. Eggs of other members of the *signoreti* group are likely to possess these features.

Eggs of the genus *Ambrysus* have been reported to have six micropyles (Hinton 1981), and those of an unspecified species from Aruba, Netherlands Antilles, usually have at least five (Cobben 1968). The individual micropylar tubes of *Ambrysus* are fused into a single, prominent plug (Cobben 1968). Our internal examinations have revealed two micropyles in each of three species of *Ambrysus* and three in two other species. Although it is likely that intraspecific variation exists in micropyle number for species of *Ambrysus*, as has been observed in species of other naucorid genera [e.g., *C. hungerfordi* (Sites and Nichols 1993)], we have observed only two and three micropyles. Thus, our data do not corroborate Hinton's (1981) report of six nor Cobben's (1968) report of five or more micropyles for species of *Ambrysus*.

In sharp contrast to *Ambrysus*, the number of micropyles for species of *Limnocoris* is clear with external examination because micropylar fusion is minimal. For *Limnocoris lutzi* and *Limnocoris* sp. [Ecuador, see Sites (1990)], two micropyles are clearly evident. Of 10 eggs of *Limnocoris moapensis* (La Rivers), eight had three micropyles whereas the other two had two micropyles. Previous reports for *Limnocoris* micropyles are nonexistent.

The number of micropyles for species of *Pelocoris* is unclear and the degree of fu-

sion differs interspecifically. Sites (1991) revealed two partially-fused micropyles for *P. poeyi*. Surprisingly, for *P. femoratus*, the micropyle number has not previously been given despite three separate descriptions of eggs [Torre Bueno 1903, Hungerford 1927 as *P. carolinensis* (see La Rivers 1948b), McPherson et al. 1987]. *Pelocoris femoratus* micropyles are fused into a plug ['micropylar boss' of Torre Bueno (1903)] similar to that of *Ambrysus*. The form of the plug is inconsistent, and a canal leading to a micropylar opening may be observed in some specimens.

In the only report for eggs of species of the subfamily Potamocorinae, which is considered by some to represent a distinct family level taxon (e.g., Štys and Jansson 1988), Cobben (1968) indicated that *C. klerkoperi* has a single micropylar opening with several external mucous projections.

#### SYSTEMATIC VALUE

The family Naucoridae is not blessed with even a modicum of somatic characters that varies among the higher taxa that may be used to elucidate systematic relationships. The principal characters that have been used for interspecific taxonomic distinctions have been adult male and female external genitalic features. Characters of nymphs and eggs have not been used, although López Ruf (1989) suggested that chorionic attributes may be valuable taxonomic characters externally at the species level and internally at the generic level. We concur with this assessment. Specifically, intergenerically variable characters include the relative widths of the chorionic inner and outer layers and pore canal configuration. Although the number of micropyles does not vary appreciably among these genera, the degree of external fusion of the individual micropylar tubes may be a taxonomically valuable character at generic or higher levels. External chorionic patterns are quite valuable as an interspecific diagnostic character in certain genera (e.g., *Ambrysus*). However, the pattern is invariant

among the four species of *Limnocoris* that we have examined. Thus, the utility of this character in providing systematic resolution appears to be restricted to particular genera.

#### ACKNOWLEDGMENTS

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